# Chapter 7
# Science and Technology: Public Attitudes and Public Understanding

## Contents

# Highlights

## Interest in Science and Technology

- **American adults express a high level of interest in new scientific discoveries and in the use of new inventions and technologies.** This level of interest has remained high for more than two decades and reached a new high point in 1997. Individuals with more years of formal education and more courses in science and mathematics are more likely to indicate a high level of interest in science and technology.
- **About one in five Americans think that they are very well-informed about new scientific discoveries and about the use of new inventions and technologies.** Americans with more years of formal education and more courses in science and mathematics are significantly more likely to view themselves as very well-informed than others. Men are significantly more likely to indicate that they are very well-informed about science and technology, holding constant the level of formal education and the level of science and mathematics education.

## Understanding Basic Scientific and Technical Concepts

- **There is a wide distribution in the level of measured understanding of scientific terms and concepts among American adults.** On a 0-100 scale, the mean score was 55. This score has remained relatively constant since 1988. Individuals with more years of formal schooling and more courses in science and mathematics obtained significantly higher scores, demonstrating the pervasive effect of science and mathematics education throughout the adult years.
- **One-quarter of Americans understands the nature of scientific inquiry well enough to be able to make informed judgments about the scientific basis of results reported in the media.** Public understanding of the nature of scientific inquiry was measured through questions concerning the meaning of scientific study and the reasons for the use of control groups in experiments. Individuals who have completed more years of formal schooling and more courses in science and mathematics were significantly more likely to understand the nature of scientific inquiry than other citizens.
- **The mean score of American adults on an indicator of understanding of basic scientific concepts was tied for first with Denmark, followed closely by the Netherlands and Great Britain; it was higher than the mean scores of adults in Germany, Canada, Japan, Italy, and six other European industrial nations.** This result is in sharp contrast to results produced by American students in the Third International Mathematics and Science Study.

## Attentive Public for Science and Technology Issues

- **Approximately 27 million Americans—14 percent—are attentive to science and technology policy issues, a level that has increased in recent years.** In complex modern societies, it is not possible for citizens to become and remain informed about the full range of public policy areas. Some degree of issue specialization is inherent in industrial societies.

## Sources of Scientific and Technical Information

- **Americans receive most of their information about public policy issues from television news programs and newspapers.** When placed on a uniform metric of the number of uses or hours per year, the public consumption of television news and newspapers dwarfs all other information sources. In 1997, Americans watched an average of 432 hours of television news and read 196 newspapers in a 12-month period. During this same period, Americans watched 72 hours of science shows on television. Individuals with cable or satellite TV service watch more science television programs than people without this service.
- **Fifty-seven percent of Americans use a computer at home or at work.** Computer use has increased steadily during the last decade. In 1997, a typical American used a computer at work for an average of 369 hours and used a home computer for an additional 130 hours. A significantly higher proportion of college graduates use a computer than of individuals with fewer years of schooling.
- **In 1997, an estimated 11 percent of Americans lived in a household with more than one working computer.** In contrast, only 8 percent of Americans had any access to a home computer in 1983.

♦ **Nearly 32 million Americans have a home computer that includes a modem, and 18 percent of adults reported in 1997 that they had used an on-line computer service during the preceding year. This is a significant increase in home access to on-line resources since 1995.** In 1997, 29 percent of adults in the United States reported having a home computer with a CD-ROM reader, opening additional information acquisition opportunities. Nearly two-thirds of Americans with a graduate or professional degree have a home computer with a modem, compared to 31 percent of those with a high school degree. Similarly, 41 percent of Americans with a graduate degree reported that they use an on-line computer service, compared to only 17 percent of high school graduates.

♦ **Twelve percent of adults—approximately 22 million people—indicated that they had previously tried to find some specific items of information on the Web.** This pattern of response indicates that people are using the Web as they might use reference materials in a library. An analysis indicated that approximately 6.5 million Americans had attempted to find some information on the Web about a specific health condition or problem, and approximately 8.8 million had tried to find some scientific information on the Web—including information on the space program, environmental information, and computer information.

## Attitudes Toward Science and Technology

♦ **Americans continue to hold the scientific community in high regard.** According to the most recent General Social Survey, approximately 40 percent of Americans have a great deal of confidence in the leadership of the scientific community and in the leadership of the medical community. These levels of national esteem have been stable for nearly two decades and are far higher than the levels reported for the leadership of other major institutions in society.

♦ **Americans hold positive attitudes toward science and technology and have high expectations for future benefits from science.** When two sets of attitude questions were converted into 0-100 scales reflecting the *promise of science* and *reservations about science*, Americans posted a mean score of 70 on the Index of Scientific Promise and 37 on the Index of Scientific Reservations. This level of reservation is the lowest reported by citizens in major industrial nations. On a separate measure that asked citizens to assess the relative benefits and potential harms from scientific research, 75 percent of Americans believe tha the benefits of scientific research outweigh any present or potential harms. This level of positive assessment of scientific research has been stable for four decades and is consistent with the high esteem noted above. College graduates and citizens attentive to science and technology policy hold even more positive views of science.

♦ **Despite their positive views of scientific research, Americans are deeply divided over the development and impact of several important technologies:** nuclear power, genetic engineering, and space exploration. For more than a decade, Americans have been evenly divided on the benefits and harms of using nuclear power to generate electricity. A similar division exists over the benefits and potential harms of genetic engineering, but there is a clearer difference by level of education. College graduates hold a much more positive view of genetic modification research. The general public is evenly divided over the relative benefits and costs of the space program. College graduates and those who are attentive to space exploration remain very positive toward the program.

♦ **Nearly 80 percent of Americans agree that the Federal Government should support basic scientific research that advances the frontiers of knowledge even when it does not provide any immediate benefits.** Asked of national samples of American adults since 1985, total public approval of government support of basic scientific research has remained constant at about 80 percent throughout the last decade. During the same time period, approximately 90 percent of Americans with a baccalaureate degree voiced approval for government support of basic scientific research.

# Introduction

## Chapter Overview

Science and technology have become integral components of the American culture. Over 85 percent of Americans believe that the world is better off due to science, and this level of general support has continued over the last four decades. Americans believe that scientists and engineers can cure diseases, explore space, and develop ever faster modes of communication. The growth of interest in science and technology is reflected in extensive use of informal science learning resources, from television to the World Wide Web. Paradoxically, this pattern of high expectation for science and technology is not matched by a comparable level of understanding of the scientific process or of basic scientific concepts.

In a democratic society such as the United States, it is important to understand attitudes about scientific and technological issues. Over the last two decades, the *Science & Engineering Indicators* studies have built a comprehensive database that helps to illuminate patterns of change. It is equally important to apply current social science theory to the understanding and interpretation of these data. A series of analyses describes the structure and patterns of change and stability in public attitudes toward science and technology.

Today, the means of communication change as rapidly as the substance of science and technology. It is important for the scientific community to communicate with the public about the promise and needs of science. To do so requires an understanding of the sources of information that people use and of which people use each of the various kinds of media for communication.

## Chapter Organization

This chapter begins with a discussion of the level of public interest in selected areas of science and technology, and examines changes in the patterns of public interest in these issues over the last two decades.[1] The level of interest in science and technology issues is an indicator of both the visibility of the work of the scientific community and of the relative importance accorded science and technology by society.

The second section of this chapter examines the level of public understanding of basic scientific concepts and the nature of scientific inquiry, looking at patterns of change over the last decade. The level of public understanding of basic scientific terms and concepts is compared for 14 leading industrial nations.

The third section of the chapter examines two sets of general, or filtering, attitudes toward science and technology. One filter reflects an individual's belief in the promise of science and technology to improve the quality of life, while another reflects the level of concern or reservation about possible negative impacts from science or technology. General attitudes in the United States and 13 other industrial nations are compared.

The fourth section analyzes the linkage between these general attitudinal filters and the policy preferences of citizens regarding government spending for basic scientific research. The development of these structural relationships over the last decade in the United States is examined, and the patterns found in the United States are compared with those for 13 other industrial nations.

The fifth section analyzes the sources of information used by citizens to improve and maintain their understanding of scientific and technical issues. This analysis examines the growth of computer access and use in the United States. New information is provided about access to electronic networks and the purposes for which individuals use the Internet.

The final section summarizes the results described in this chapter and discusses some of their major implications.

# Interest in Science and Technology

Citizens of modern industrial societies like the United States live in the midst of a wide array of technologies—old and new. Most Americans now use a computer at home or work, drive automobiles controlled by computer chips, watch weather reports with satellite images only hours old, and take pharmaceuticals based on new biotechnologies unknown a decade ago. The media carry frequent reports of the results of scientific research, with a strong emphasis on biomedical research and results. The recent landing on Mars of an explorer that is essentially operated from the earth, and live coverage of the vehicle's movements and preliminary findings symbolize the interesting mix of technology and science experienced by the public.

Modern science and technology are only a part of the daily array of interesting and important news events. As interesting as science and technology may be to scientists and others knowledgeable about their activities, among the general public they compete with the demands of family and work, and many entertainment and educational opportunities. Individuals in modern industrial societies have to make choices

[1]Twelve of the 13 *Indicators* volumes published since 1972 have included a chapter on public attitudes toward and understanding of science and technology. The studies for the 1972, 1974, and 1976 *Indicators* were based on a block of 20 items inserted into an omnibus national personal interview survey conducted by Opinion Research Corporation of Princeton, New Jersey. The 1979 study was designed by Miller and Prewitt (1979) and analyzed by Miller, Prewitt, and Pearson (1980); the personal interviews were conducted by the Institute for Survey Research at Temple University. Additional national studies were supported by the 1982, 1985, 1987, 1991, and 1993 *Indicators* reports, with telephone interviews conducted by the Public Opinion Laboratory at Northern Illinois University. The chapter for *Science Indicators 1985* was based on a national telephone study conducted by the Public Opinion Laboratory for Professor George Gerbner of the Annenberg School of Communication at the University of Pennsylvania. In 1995 and 1997, the Chicago Academy of Sciences conducted studies that continued the core of attitude and knowledge items from previous *Indicators* studies and included telephone interviews with a random-digit sample of 2,006 adults in 1995 and 2,000 in 1997. The interviews for the 1995 study were conducted by the Public Affairs Division of Market Facts Incorporated. The interviews for the 1997 study were conducted by the National Opinion Research Center. The results can be found in past volumes of *Indicators* (NSB biennial series). The data from these studies are available for secondary analysis from the International Center for the Advancement of Scientific Literacy at the Chicago Academy of Sciences.

about how they spend their time, the issues that they will attend to (if any), and the level of participation they will devote to them.

## Interest in Science and Technology Issues

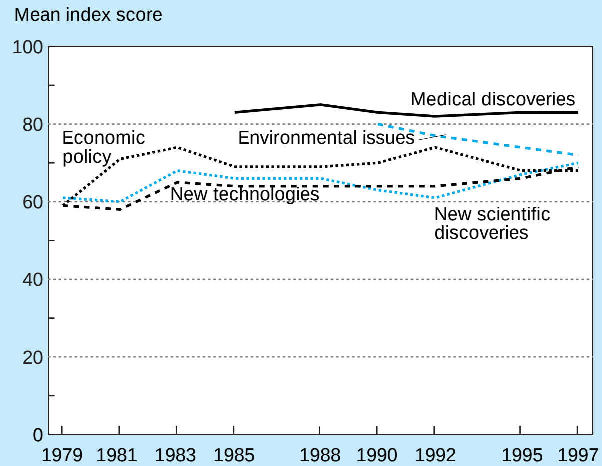
The level of interest in science and technology in the United States has remained high during the last two decades, reaching a new high point in 1997. Using a 0-100 Index of Issue Interest, the mean level of public interest in new scientific discoveries has risen from 61 in 1979 to 70 in 1997. (See figure 7-1 and appendix tables 7-1, 7-2, and 7-3.) In a parallel pattern, public interest in issues concerning the use of new inventions and technologies has grown from 59 in 1979 to 69 in 1997. Interest in medical discoveries has remained high throughout the last decade. There is some evidence that interest in environmental issues has declined slightly. In the early 1990s, interest in environmental issues was comparable to the level of interest in medical discoveries; by 1997, interest in environmental issues was about the same as interest in economic policy issues.

The level of interest in a particular issue area reflects both a core group of citizens with a long-term interest in that particular issue, plus some citizens who become more interested due to short-term policy disputes or activities. The nearly two decades of data collected by the *Science & Engineering Indicators* program demonstrate several of these patterns. The incoming Reagan Administration focused substantial attention on a reexamination of economic policies in the early 1980s, leading to a series of major disputes with Congress. These policy differences and the extensive media coverage of the debate were reflected in a substantial increase in the levels of public interest in economic issues and business conditions from 1979 to 1981, with additional growth of interest in 1993. The current Administration has emphasized the need for a strong scientific base for the United States and has focused attention on the World Wide Web and on increasing student access to computers in elementary and secondary schools.

Individuals with higher levels of formal education and more high school and college coursework in science and mathematics were significantly more likely to register higher levels of interest in new scientific discoveries, the use of new inventions and technologies, and space exploration than other citizens. (See figure 7-2 and appendix table 7-3.) In contrast, individuals with higher levels of formal education expressed only a slightly higher interest score for medical discoveries, nuclear power, and environmental issues than other adults.

In 1997, men were more likely than women to indicate a high level of interest in the use of new inventions and technologies, and space exploration. Women were more likely to express a high level of interest in medical discoveries and environmental issues than men.

Figure 7-1.
**Indices of public interest in selected policy issues**




NOTES: Each index is a summary measure of respondent reports that they are "very interested," "moderately interested," or "not at all interested" in each specific issue. A value of 100 was assigned to a "very interested" response, and a value of 50 was assigned to a "moderately interested" response.

See appendix table 7-1. *Science & Engineering Indicators – 1998*

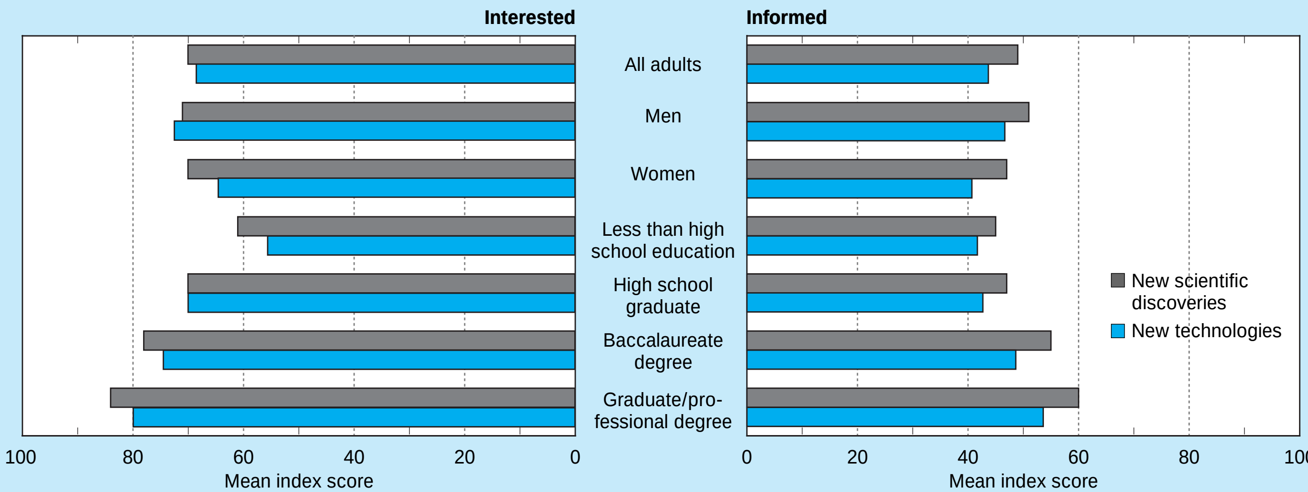
## Informedness About Science and Technology Issues

In contrast to the levels of interest reported above, American citizens report lower levels of information about these same issues. Nevertheless, the levels of informedness about selected scientific issues have risen over the past two decades. Using a 0-100 Index of Issue Informedness,[2] the mean level of informedness about new scientific discoveries has increased from 36 in 1979 to 49 in 1997. Informedness about new inventions and technologies experienced a similar increase—from 35 in 1979 to 44 in 1997. (See figure 7-3 and appendix tables 7-4, 7-5, and 7-6.) Throughout the last decade, the public reported the highest recorded mean level of informedness about medical discoveries.

It is important to understand how individuals assess their own knowledge of these subjects. For many purposes—from deciding which cleaning product will be most effective to writing a legislator on a current issue—it is the individual's self-assessment of his or her knowledge that will either encourage or discourage a given behavior (Rosenau 1974, Miller 1983a, and Miller 1996b). Only 16 percent of American adults think of themselves as

[2]"Informedness" is a useful short-hand term to denote an individual's self-assessment of his or her level of understanding of a particular issue area. The Index of Issue Informedness is a summary measure reflecting each individual's self-assessment as "very well-informed," "moderately well-informed," or "poorly informed" on a specific issue. A score of 100 points was assigned to a "very well-informed" response, and a score of 50 points was assigned to a "moderately well-informed" response. "Poorly informed" responses received a score of 0 points. The index score is the mean value of the responses for any year or group.

Figure 7-2.
**Indices of public interest in and self-assesed knowledge about scientific and technological issues, by sex and level of education: 1997**




See appendix tables 7-3 and 7-6. *Science & Engineering Indicators – 1998*

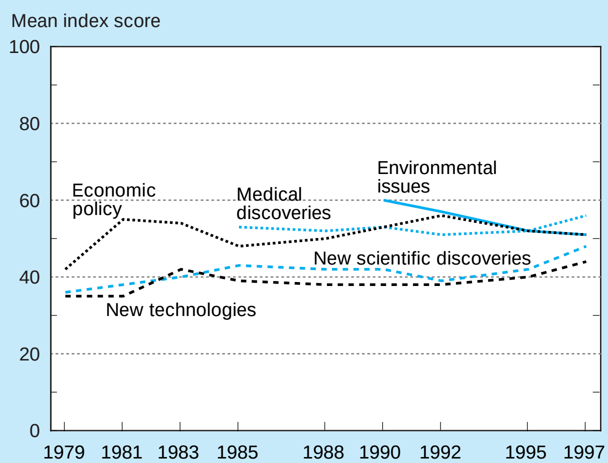
being very well-informed about space exploration, and only 10 percent think they are very well-informed about the use of nuclear power to generate electricity.

Comparatively, 28 percent of American adults feel that they are very well-informed about medical discoveries, and 23 percent reported that they are very well-informed about environmental issues. Medical concerns and issues tend to affect daily life for more people than issues such as nuclear power or space exploration, and it is not surprising that there is a more pervasive sense of being better informed about more personal issues than more distant ones. Similarly, individuals who can see the air pollution around major cities or who have to modify their plans due to ozone alerts or polluted beaches may feel better informed about environmental issues than about more distant topics.

The influence of formal education and prior coursework in science and mathematics on most individuals' perception of their understanding about scientific and technical issues is substantial. In 1997, for example, individuals who did not graduate from high school had a mean score of 42 on informedness about the use of new inventions and technologies, compared to 54 for graduate degree-holders. (See figure 7-2 and appendix table 7-6.) In contrast, adults who did not complete high school had a mean score of 58 for informedness about medical discoveries, compared to 61 for graduate degree-holders.

Although the levels of self-reported understanding are significantly lower than the levels of interest in the same issues, the levels of self-perceived understanding are increasing. The sense of being very well-informed about new scientific discoveries increased from 13 percent in 1995 to 19 percent in 1997. Similarly, the sense of being very well-informed about the use of new inventions and technologies increased from 12 percent in 1995 to 16 percent in 1997. As discussed later in this chapter, this rise in self-perceived understanding parallels an increase in the use of science-related media and informal educational resources.

Figure 7-3.
**Indices of public informedness on selected policy issues**




NOTES: Each index is a summary measure of respondent reports that they are "very well-informed," "moderately well-informed," or "poorly informed" about each specific issue. A value of 100 was assigned to a "very well-informed response," and a value of 50 was assigned to a "moderately well-informed" response.

See appendix table 7-4. *Science & Engineering Indicators – 1998*

## Attentiveness to Science and Technology Issues

Given the large number of issues on the public policy agenda at any point in time, it is impossible for citizens to remain interested in and informed about all public policy matters. In a pluralistic society like the United States, some individuals may follow agricultural issues and foreign policy issues closely, but have little interest in science or technology issues. Other citizens may have a high level of interest in science and technology policy issues as well as foreign policy issues, but no interest in agricultural issues. All citizens, including virtually all legislators, must be selective regarding the areas and issues about which they seek to be sufficiently informed to participate in policy discussions. This process of issue specialization is a fact of political life in modern industrial societies.

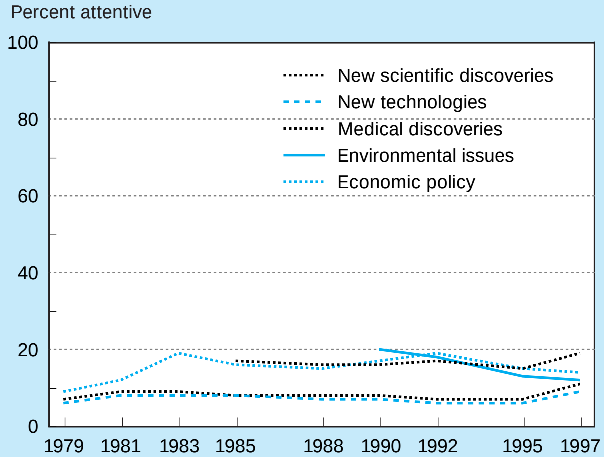
Citizens who display a high level of interest in an issue area, who feel well-informed about it, and who show at least a minimal pattern of information acquisition are classified as *attentive* to that issue.[3] A citizen with a high level of interest in a particular issue, but who does not feel well-informed about it, is classified as a member of the *interested* public for that issue. Citizens without a high level of interest in a specific issue are referred to as the *residual* public for that issue area. There is an attentive public for every major public policy area; these publics differ in size and composition.

Reflecting the increased sense of informedness noted above, the percentage of American adults attentive to science and technology policy increased over the past decade, rising from 11 percent in 1988 to 14 percent in 1997. This attentive public includes approximately 27 million American adults and is the same size as the attentive public for economic policy. By comparison, 19 percent of Americans were attentive to medical discoveries in 1997, but only 12 percent were attentive to environmental issues. Only 5 percent of American adults were attentive to foreign policy and 4 percent to nuclear power issues. (See figure 7-4 and appendix table 7-7.)

There is a direct correlation between attentiveness to science and technology policy issues and years of formal schooling and the number of science and mathematics courses taken during high school and college. (See figure 7-5 and appendix table 7-8.) Only 15 percent of individuals with less than a high school diploma are attentive to science and technology policy issues, compared to 30 percent of graduate and professional degree-holders. Similarly, 10 percent of those with limited coursework in science and mathematics were attentive to science and technology policy issues, compared to 28 percent of those with nine or more high school or college science or math courses. Men were slightly more likely to be attentive to science and technology policy issues than women, but the magnitude of this difference was smaller in 1997 than in previous years.

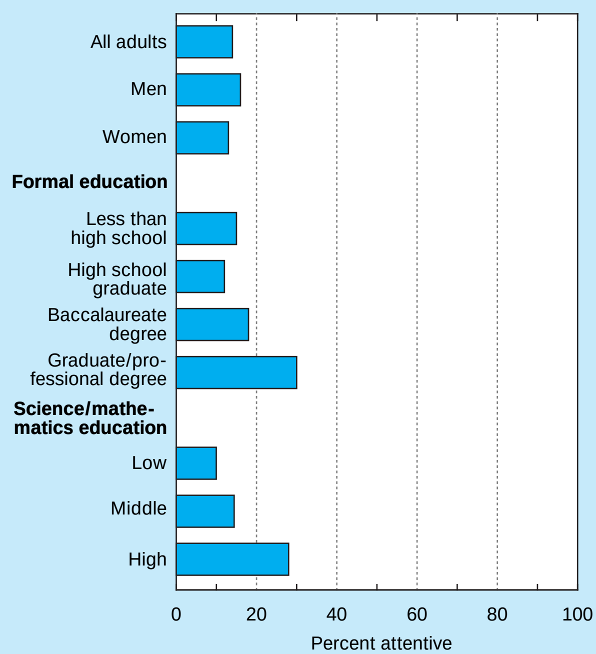
[3]A minimal pattern of information acquisition consists of either reading a newspaper on a daily basis or reading a weekly or monthly magazine relevant to the issue area. For a general discussion of the concept of issue attentiveness, see Almond (1950); Rosenau (1974); Miller (1983a); and Miller, Pardo, and Niwa (1997).

Figure 7-4.
**Public attentiveness to selected policy issues**




See appendix table 7-7. *Science & Engineering Indicators – 1998*

Figure 7-5.
**Attentiveness to science and technology policy, by sex and level of education: 1997**




See appendix table 7-8. *Science & Engineering Indicators – 1998*

## Understanding of Scientific and Technical Concepts

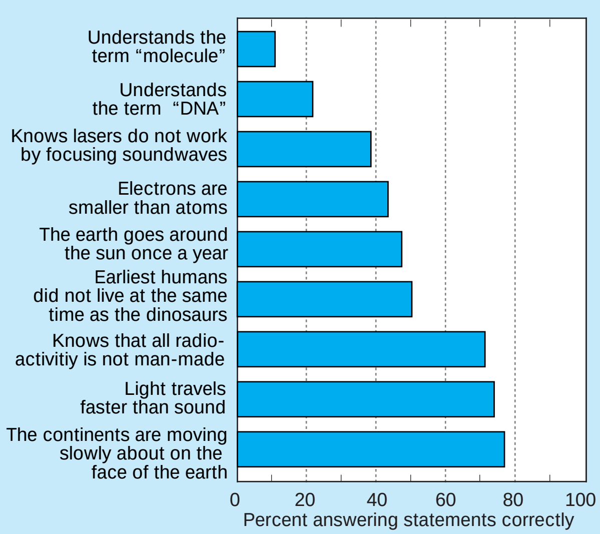
The modern citizen lives in a sea of words. The daily newspaper includes thousands of words to attract interest. Television news adds pictures and color, but requires accompanying spoken words to be enlightening. Increasingly, headlines, news stories, telecasts, magazine articles, and instruction manuals use a vocabulary of scientific terms and concepts, often assuming that most readers or viewers will understand them. This section looks at the level of public understanding of science and technology concepts.

### Understanding of Basic Concepts

An understanding of a basic set of scientific concepts is an important prerequisite for understanding discussions of science and technology, and for participating in the process of formulating science and technology policy. While the range of possible scientific terms or concepts is large, it is possible to identify a sample of items that concern the composition of matter, the nature of the universe, the basic processes that have shaped our planet, and the basic biology that supports life. A set of nine knowledge items can be used to estimate the level of scientific construct understanding in the United States over the last decade.

Looking at the level of understanding on the individual items, it appears that only 11 percent of Americans can define the term "molecule." (See figure 7-6 and appendix table 7-9.) A large proportion of the population knows that a molecule is a small piece of matter, but is unable to relate it to an atom or a cell, which are also small pieces of matter.

Figure 7-6.
**Public understanding of scientific terms and concepts: 1997**




NOTE: See appendix table 7-9 for exact wording of statements.

See appendix table 7-9. *Science & Engineering Indicators – 1998*

One in five Americans was able to provide a minimally acceptable definition of DNA. And, despite substantial media attention to deep space probes and pictures from the Hubble Space Telescope, only 48 percent of Americans know that the earth goes around the sun once each year.

On the positive side, 78 percent of Americans recognize that portions of the earth's crust—thought of in terms of continents—have been moving for millions of years and will continue to move in the future, and 75 percent know that light travels faster than sound. About 71 percent of American adults reject the idea that all radioactivity is man-made. Despite this promising level of understanding of these basic physical and geological concepts, only 39 percent of American adults disagreed with the statement that "lasers work by focusing soundwaves." Perhaps reflecting the legacy of Fred Flintstone, only half of Americans rejected the statement that "the earliest humans lived at the same time as the dinosaurs."

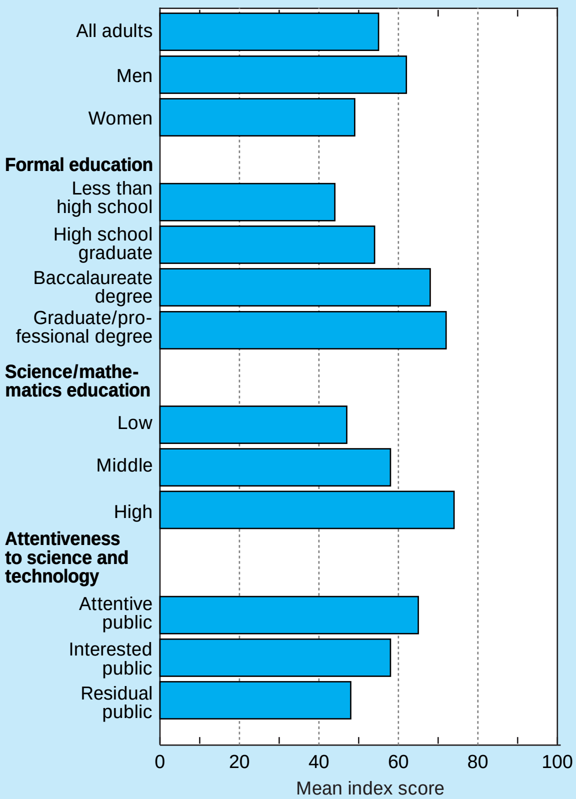
Using the same testing technology used in many national and international tests, the responses to these nine items were converted into a 0-100 scale.[4] The mean score for American adults on the Index of Scientific Construct Understanding was 55, the same as in 1995 and comparable to 1988 and 1990 index scores. (See figures 7-7 and 7-8 and appendix table 7-10.) Understanding of scientific constructs was strongly related to both the level of formal education and the number of high school and college science and mathematics courses taken. The mean score for college graduates was 68, compared to 44 for individuals who did not complete high school. Individuals who completed nine or more high school and college science or math courses had a mean score of 74, compared to 47 for adults who had five or fewer courses.

Men scored significantly higher than women, with a mean score of 62 compared to 49 for women. (See figure 7-7 and appendix table 7-10.) The scores partly reflect differences in coursetaking patterns, with men traditionally taking more science and mathematics courses than women. Several studies from the last decade indicate that this coursetaking gap has been nearly eliminated in mathematics and in science.[5]

[4]The items included on the construct vocabulary dimension were first identified by a confirmatory factor analysis. To place these items on a common metric that would be applicable to studies in the United States and to studies conducted in other countries, a set of item-response theory (IRT) values were computed for each item which takes into account the relative difficulty of each item and the number of items used in each study. This technique has been used by the Educational Testing Service and other national testing organizations in tests such as the Test of English as a Foreign Language (TOEFL), the computer-based versions of the Graduate Record Examination (GRE), and the National Assessment of Educational Progress (NAEP). The original IRT score for each respondent is computed with a mean of 0 and a standard deviation of 1, which means that half of the respondents would have a negative score. To put the result in more understandable terms, the original IRT score was converted to a 0-100 scale. See Zimowski et al. (1996) for a more complete discussion of item response theory. For more information on confirmatory factor analysis, see Long (1983) or Loehlin (1987).

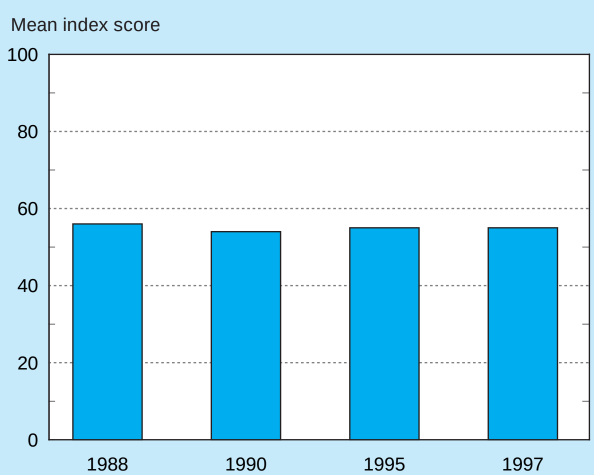
[5]See Legum et al. (1993), Matti et al. (1994), and NCES (1997) for a more complete discussion of changes in mathematics and science coursetaking by sex.

Figure 7-7.
**Mean score on Index of Scientific Construct Understanding, by sex, level of education, and attentiveness to science and technology: 1997**




See appendix table 7-10. *Science & Engineering Indicators – 1998*

Figure 7-8.
**Mean score on Index of Scientific Construct Understanding**




SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

*Science & Engineering Indicators – 1998*

## Understanding of Scientific Inquiry

To handle the daily flow of news reports about scientific and medical findings, citizens must understand the nature of scientific inquiry. A major difficulty in measuring the public understanding of scientific inquiry is that science does not utilize a single uniform procedure. While some sciences rely heavily on experimental procedures, others depend primarily on observation, measurement, and model building and testing. Other sciences depend heavily on fossil discovery, classification, and the construction or integration of possible developmental sequences. Virtually all of these approaches are utilized to some degree under the broad umbrella of scientific inquiry.

What is central to all scientific endeavor, however, is the effort to build theories or models to enhance our understanding of nature and the materials and processes found in nature. Parallel to the theory-building process is a commitment that all theories must be subject to logical or empirical falsification. Thus, the first level of conceptualization of science is an activity for the purpose of building and testing theory.[6]

At a second level, some individuals think of all scientific inquiry as a form of experimental investigation. This may reflect an understanding that scientific ideas are subject to testing. Popper's concept of falsification is not widely known (Popper 1959), and most people still think that scientists prove their theories or ideas much as a mathematician might "prove" a theorem. Thus, a second important level of public understanding of scientific inquiry involves the view of science as the conduct of experimentation. This view is reinforced by frequent media reports of medical and pharmaceutical trials of new procedures or products.

At a third level, some people simply think of science as rigorous comparison. This view of science is largely devoid of any notion of theory building. It lacks understanding of experimentation as the use of random assignment and control groups, or of the purposes for those procedures. It does view science as empirical in character, often perceiving science as "testing," as against some known standard.

[6]While there is broad consensus that theory building is the primary objective of science, this level of conceptualization is relatively rare in the public and not universal among graduates of science, engineering, or medical programs. The measurement of the understanding of scientific inquiry at this level is compounded by the dual meaning of "theory" in American English. In the usage employed above, "theory" refers to comprehensive sets of statements about the operation of various aspects of nature, or the development of models of natural processes. This usage would apply to generalizations or models in the biological, social, or physical sciences. At the same time, "theory" is often used in everyday language to refer to speculations or suppositions not yet supported by evidence. For example, it is common to hear a person dismiss a speculation by another person by saying that it is "only a theory," meaning that there is no evidence, or insufficient evidence, for that conclusion. Ironically, this is almost exactly the opposite meaning of the term as used in science.

This duality of meaning creates an interesting measurement problem. When a respondent is asked, for example, what it means to study something scientifically, and responds that it has to do with "making theories and things," it is not clear whether the individual means to use theory in a Kuhnian (Kuhn 1962) sense or as an unsupported speculation. For this reason, it is important to ask these questions in an open-ended format and to probe the responses.

Below these levels of conceptualization, many individuals have some awareness of the word “science,” but no cognitive substance behind the word. It may be associated with precise measurement or with good or bad outcomes (medical miracles or weapons of mass destruction), but the work of scientists and the process of scientific inquiry are not understood. Most of these individuals hold positive attitudes toward science, and expect it to cure most diseases and to solve environmental problems. There is, however, a higher level of reservation among these individuals, which may reflect their recognition of the enormous power of science and technology and their inability to understand it.

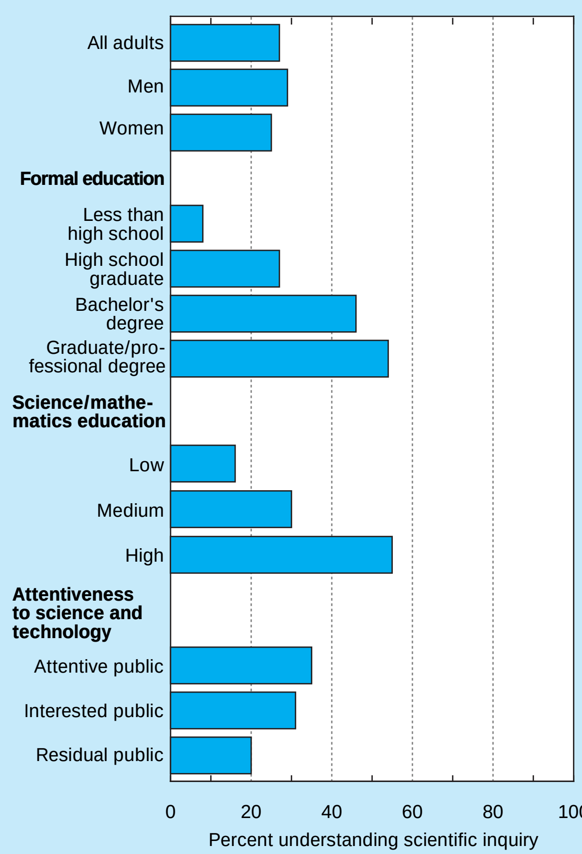
To find out how well the public understands the nature of scientific inquiry, adults have been surveyed in a series of *Science & Engineering Indicators* studies over the last decade. They were asked to define the meaning of scientific study, and their responses have been recorded and coded. In 1995 and 1997, each respondent was asked the same open-ended question about scientific study and given a set of questions concerning an experimental evaluation of a drug.[7] They were also asked a set of questions concerning the meaning of probability, using an example of an inherited illness.[8] Each respondent was classified, using a combination of these responses, as having or not having at least a minimal level of understanding of the nature of scientific inquiry.[9] In 1997, approximately 27 percent of American adults met the standard of having a minimal understanding of the nature of scientific inquiry, continuing a gradual increase over the last decade. (See figure 7-9 and appendix table 7-11.)

## International Comparisons

It is possible to obtain a sense of international commonalities and differences by comparing the mean scores on the Index of Scientific Construct Understanding for 14 of the leading industrial nations. Using the 100-point index described above, the United States, Denmark, the Netherlands, and Great Britain all produced mean scores of between 53 and 55. (See figure 7-10 and appendix table 7-12.) Although the years in which the data were collected from the other countries range from 1989 to 1992, the provision of the three time periods for the United States illustrates the stability of the U.S. estimate; there is no basis for assuming a more rapid change in other major industrial nations.

The results of the Third International Mathematics and Science Study (TIMSS) are relevant to this discussion since they showed that students in the United States ranked in the middle range of industrial countries. (See chapter 1.) There are a number of plausible reasons why American adults may

Figure 7-9.
**Public understanding of the nature of scientific inquiry: 1997**




See appendix table 7-11. *Science & Engineering Indicators – 1998*

[7]The question on the meaning of scientific study was:

“When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?”

*If response is “clear understanding” or “general sense”:* “In your own words, could you tell me what it means to study something scientifically?”

In addition, each respondent was asked the following question:

“Now, please think of this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?”

[8]The text of the probability question was: “Now think about this situation. A doctor tells a couple that their ‘genetic makeup’ means that they’ve got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple’s children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?”

[9]The level of understanding of the nature of scientific inquiry is estimated by looking at responses to a series of open-ended and multiple-part questions. To qualify as understanding the nature of scientific inquiry, a respondent had to (1) either provide a theory-oriented response to an open-ended question about the meaning of scientific study or provide a correct response to an open-ended question about an experiment and (2) be able to provide a correct response to a series of four separate queries about the meaning of the probability of one-in-four, using an example of an inherited illness.

Figure 7-10.
**Mean score on Index of Scientific Construct Understanding in 14 countries**


See appendix table 7-12. *Science & Engineering Indicators – 1998*

score ahead of, or equal to, adults in other industrial nations. First, a higher percentage of U.S. youth have enrolled in postsecondary schooling for most of the last five decades. A second possible reason is that there has been and continues to be a more pervasive use of general education requirements in the United States, which include one or more years of college-level science instruction for all college students, regardless of degree or career objective. In Europe and Japan, fewer youth enroll in college or university, and postsecondary students who do not plan a career in science or related fields are not required to take college-level science or mathematics courses. It is also possible that college-level science instruction in the United States is enhanced by informal science learning resources. These include zoos, aquariums, museums, science television programs, science magazines, public libraries, and the World Wide Web. Other reasons are based in the methodologies of these studies. The ability of TIMSS performance to predict a student's adult knowledge has not been established. Different testing instruments and procedures can lead to substantial differences in results. The factors associated with these differences merit further study.

## Attitudes Toward Science and Technology Policy Issues

One of the areas of inquiry that social psychology and learning research has focused on is the development of public attitudes toward a variety of subjects. How humans learn, think, and develop cognitive structures is an evolving and complex area of research. Some of the social psychology concepts are helpful in the analysis of public attitudes toward science and technology. Some social psychology literature indicates that most individuals, when faced with a daily barrage of complex information, often construct schemas to filter and manage information (Schank 1977; Minsky 1986; Lau and Sears 1986; Milburn 1991; and Pick, van den Broek, and Knill 1992).

A schema is a psychological structure that humans use to integrate information and experiences into coherent clusters. Individuals have schemas for simple tasks (such as driving an automobile in traffic) as well as for more complex and abstract tasks (such as understanding the impact of science on society). Schemas are usually cumulative in character and help people categorize new information while also providing an initial filtering response to the information. For example, when a driver sees a lighted arrow pointing to one side of a highway, it is likely that the driver will assume the need to turn in that direction, and may also reason that it will be necessary to slow the vehicle first. The original observation of the lighted arrow activates various prior experiences and knowledge, bringing into short-term memory a set of alternative explanations and associated behaviors.

Similarly, when an individual hears or reads a news report that a new drug tested on a large number of animals was found to reduce the development of cancer, that information may be recognized as a "scientific study" and one or more schema relevant to this subject may be activated. Although the report involves tests of a drug on animals, the individual may recognize that the results could lead to studies with more advanced animals or with humans, ultimately resulting in a drug that might be useful to humans. An individual with a strong positive schema toward science may interpret this report optimistically, expecting new medications in the foreseeable future, and reinforcing a belief that science produces things that make life healthier, easier, and more comfortable. Conversely, an individual with a strong negative schema toward science may recall other test reports that have promised results, but failed to produce them.

It is important to explore the structure of public attitudes toward science and technology in the United States and to compare it with structures found in other industrial nations. To do that, a series of analyses was conducted, and two independent dimensions were found that support the view that most individuals hold two primary schemas toward science and technology. The first dimension appears to represent belief in the promise of science and technology. A careful reading of the four items included on this dimension indicates that they all reflect either the judgment that science and technology have already improved the quality of life, with the implicit assumption that this will continue, or make a positive assessment of the likelihood of future benefits. The second dimension appears to represent personal reservations about science and technology. The four items included on this dimension express concerns about the speed of change in modern life and a sense that science may, at times, pose conflicts with traditional values or belief systems.

It is reasonable to expect many combinations of these two schemas. Some individuals may have a strong belief in the promise of science and technology and a low level of concern, leading them to react positively to a wide spectrum of science news. Alternatively, some individuals may have lower expectations about the promise of science and technology and a higher level of concern, leading them to be doubtful or negative about scientific news. It is also possible for an individual to hold both hope in the promise of science and technology and real reservations about their potential harms or dangers. Given the low salience of science and technology to many adults, it is likely that some people will have both low expectations about the promise of science and technology and little awareness or concern about potential drawbacks.

To provide a common metric for comparison, a 0-100 index was constructed for the Index of Scientific Promise and the Index of Scientific Reservations. The mean score of U.S. adults on the Index of Scientific Promise was 70 in 1997, and the mean score on the Index of Scientific Reservations was 37.[10] (See appendix tables 7-13 and 7-14.) Although the ratio between the two indices may show the relative strength of positive and negative attitudes toward science and technology, both schema operate simultaneously in most individuals. This pattern means that most Americans hold strong beliefs in the promise of science and technology to improve the quality of life and have relatively low levels of reservation about possible harms. Comparable indicators from 1992 and 1995 suggest that this pattern of American attitudes has remained stable in recent years.[11]

A comparison of the United States and 13 other industrial nations shows that the citizens of most industrial countries hold strong positive beliefs about the promise of science and technology to improve the quality of life. (See appendix table 7-16.) The citizens of the other 13 industrial nations had a mean score around 70 on the Index of Scientific Promise, suggesting a pervasive belief in the potential benefits of science and technology to improve the quality of life.

There are, however, major differences among industrial nations in the level of reservation, or concern, about potential negative effects of science and technology on traditional values and on the pace of life. Among industrial nations, American adults report the lowest levels of reservation about science and technology, with a mean score of 37. Canadians and most Europeans recorded mean reservation scores between 50 and 60, but the citizens of Greece and Portugal displayed mean scores above 66. This pattern suggests that these citizens simultaneously believe in the promise of science and technology to improve the quality of life, and hold a slightly lower—but substantial—level of concern about potential negative impacts of science and technology.

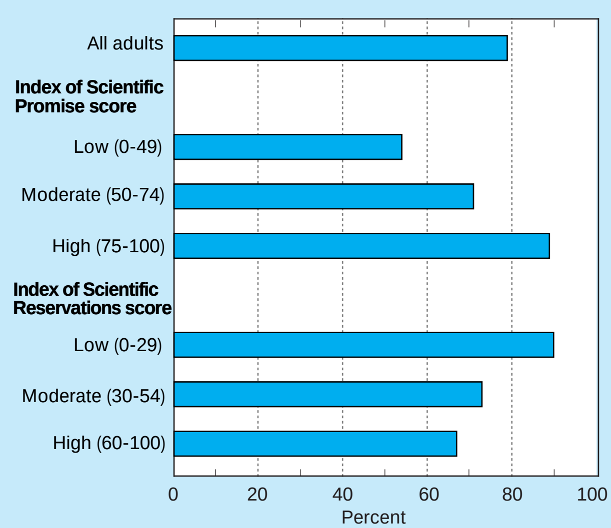
Japan is an interesting exception to this pattern. The mean score for Japanese adults on the promise index was 55, but the mean score on the reservation index was 56. The level of reservation is comparable to Canada and most European countries, but the level of belief in the promise of science and technology to improve the quality of life is essentially equal to the level of concern. While this pattern is surprising in the context of Japanese success in science and technology in recent decades, it may be a reflection of a traditional society experiencing a faster pace of social and economic change than earlier generations.

## The Linkage Between Schema and Specific Policy Preferences

To learn how these general schema function with regard to specific policy preferences, it is useful to view the responses of Americans to the statement, "Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government." Nearly 80 percent of Americans agreed with that statement in 1997, and only 18 percent explicitly disagreed with it. (See figure 7-11 and appendix table 7-17.) The same question has been asked of Americans in each of the *Science & Engineering Indicators* studies since 1985, and the results suggest that this level of support has been stable for at least a decade. Approximately 90 percent of American adults with a baccalaureate degree have voiced approval for this statement since 1985.

A careful examination of the data from 1997 suggests that these two schema play an important intermediary role in the development of specific policy preferences, such as the preference for government funding for basic scientific

Figure 7-11.
**Support for government funding of basic scientific research, by level of general support for or reservations about science and technology: 1997**




See appendix table 7-18. *Science & Engineering Indicators – 1998*

[10]See appendix table 7-14 for the frequency distribution of the eight items included in the two schema.

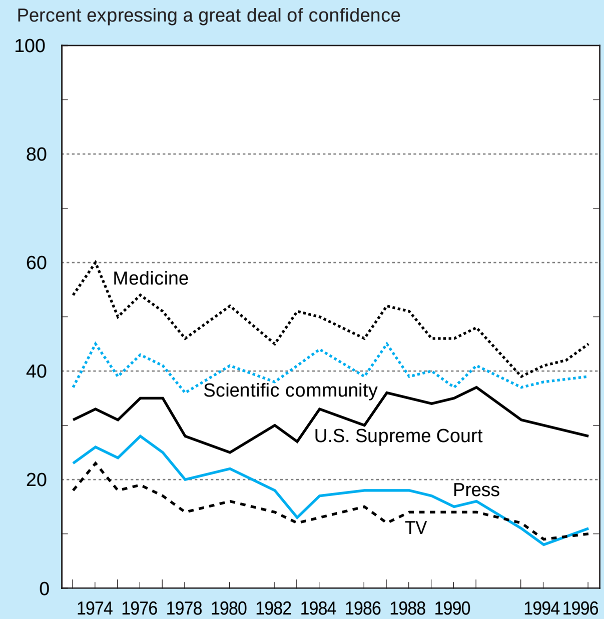
[11]Some of the items included in the Index of Scientific Reservations and the Index of Scientific Promise were included in the Attitude Toward Organized Science Scale that was reported in previous *Science & Engineering Indicators*. (See appendix table 7-15.)

research. About 54 percent of American adults who scored less than 50 on the Index of Scientific Promise agree that the Federal Government should fund basic scientific research. By contrast, 89 percent of adults with a score of 75 or more on the index supported that funding. (See figure 7-11 and appendix table 7-18.) Similarly, the level of support ranges from 67 percent among adults with a high level of reservation about the impact of science and technology to 90 percent among adults with a low level of reservation. By itself, this pattern would suggest that both of these schema operate simultaneously and in opposite directions, but other factors—such as level of education and the number of science courses taken—influence the general schema themselves; thus, the relationship is more complex. The influence of education, for example, can be seen in the percentage of support by schema score among those with different levels of education. (See appendix table 7-18.) These results confirm that both the promise schema and the reservation schema continue to operate within every level of formal education.

The results show that schema—general and long-term attitudinal filters—play an important role in the formulation and maintenance of more specific policy attitudes and preferences. It is useful to examine some additional indicators of public attitudes toward organized science in the United States.

One of the oldest indicators of the public attitude toward science and technology is the General Social Survey query (Davis and Smith annual series), which asks Americans whether they have a "great deal of confidence, only some confidence, or hardly any confidence at all" in the people running selected institutions. About 40 percent of Americans express a great deal of confidence in the leadership of the scientific community, trailing only the leadership of medicine. (See figure 7-12 and appendix table 7-19.) Comparatively, only 10 percent of adults expressed a great deal of confidence in the leadership of the press or television in 1996. This level of esteem for the leadership of the scientific community has continued during the two decades that these data have been collected.

Figure 7-12.
**Public confidence in leadership of selected institutions**




See appendix table 7-19. *Science & Engineering Indicators – 1998*

## Perceptions of Scientific Research

The longest available indicator of the relative benefits and harms of science is a question that Americans were first asked only weeks before the launch of Sputnik I in 1957. Asked to judge whether the world is better or worse off because of science, 88 percent of American adults said they thought the world was better off, and only 3 percent said that the world was worse off (Davis 1958). In the 1988 *Science & Engineering Indicators* study, this question was repeated and 88 percent still said that the world was better off due to science. In 1997, 40 years after Sputnik, 87 percent indicated that they felt that the world is better off because of science, and only 5 percent said that the world is worse off due to science. This pattern reflects a consistent post-war belief among Americans that science will improve the quality of life.

When asked in 1997 to weigh the benefits and harms of "scientific research," 75 percent of Americans indicated that the benefits had exceeded any harms, and only 12 percent took an opposing view. (See figure 7-13 and appendix table 7-20.) In 1997, 90 percent of Americans with a college degree indicated that the benefits of scientific research outweigh any harms, compared to 58 percent who did not finish high school. Of the attentive public for science and technology policy (those most likely to become involved in science or technology policy disputes), 83 percent believed that the benefits of scientific research outweigh any harms.

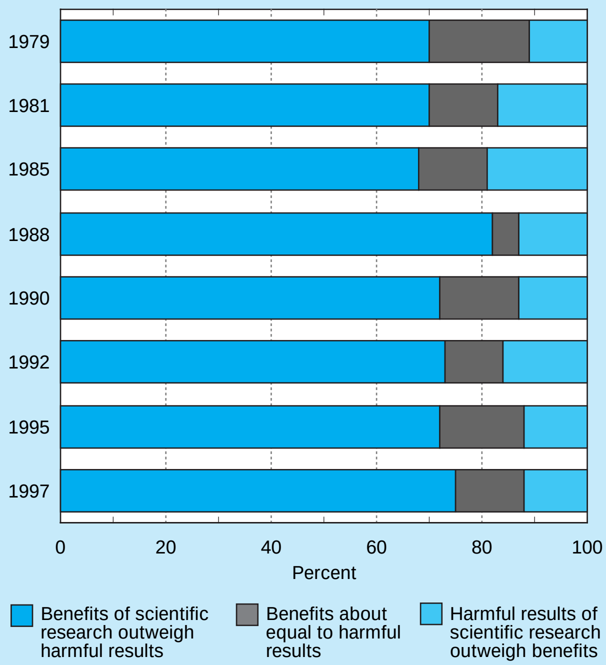
## Perceptions of Nuclear Power

Americans are not as positive about all scientific issues as they are about scientific research generally. For example, they have been evenly divided for more than a decade over the use of nuclear power to generate electricity. In 1997, 45 percent of Americans believed the benefits of nuclear power outweighed any harms, while 37 percent held the opposite view, and 18 percent thought that benefits and harms were equal. (See figure 7-14 and appendix table 7-21.)

Individuals with more years of formal schooling, males, and citizens attentive to science and technology policy were slightly more favorable in their assessment of the benefits and harms of nuclear power than other Americans, but the differences were modest.[12] (See appendix table 7-21.) The relationship between education and the assessment of nuclear power was relatively weak.

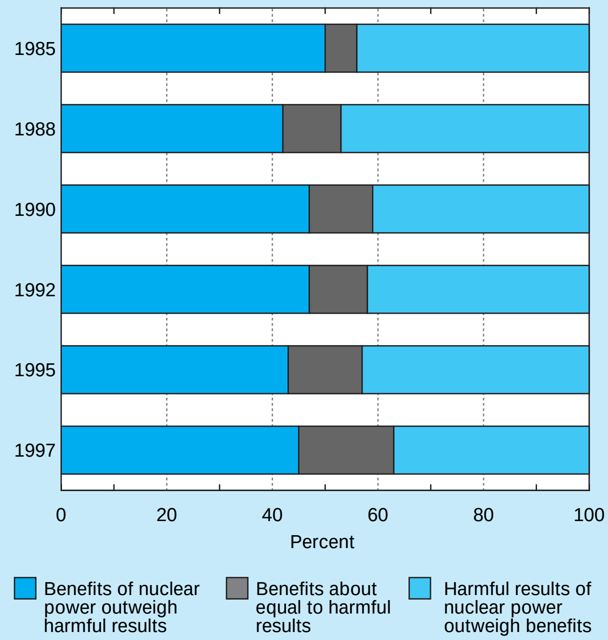
[12]These differences in attitudes by sex toward nuclear power are consistent with the findings of other studies conducted in the United States and Europe (Shapiro and Mahajan 1986, Norris 1988, and Poole and Zeigler 1985).

Figure 7-13.
**Public assessment of scientific research**




See appendix table 7-20. *Science & Engineering Indicators – 1998*

Figure 7-14.
**Public assessment of nuclear power**



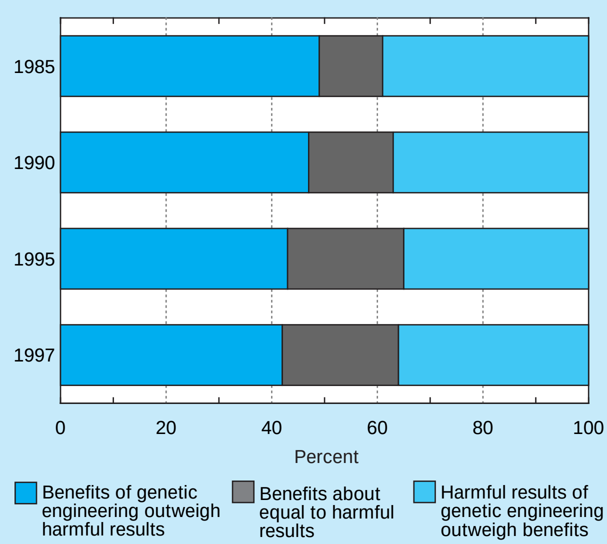

See appendix table 7-21. *Science & Engineering Indicators – 1998*

## Perceptions of Genetic Engineering

During the last 15 years, media discussion of genetic modification has increased markedly. The subject has been raised on television and in films, criminal trials, and person-of-the year awards. Americans continue to be divided in their assessment of the benefits and harms of genetic engineering. In 1997, 42 percent of Americans thought that the benefits outweighed the harms, but 36 percent concluded that the actual or potential harms were greater than the benefits. (See figure 7-15 and appendix table 7-22.) In 1995 and 1997, more Americans were undecided or thought that the harms equaled the benefits than a decade ago.

Several interesting patterns emerge regarding education, attentiveness, and sex. (See appendix table 7-22.) With respect to education, individuals with less than a high school diploma gradually shifted from more positive attitudes toward genetic engineering to more negative assessments between 1985 and 1997. Increased media attention to this topic seems to have created more worries, which create negative assessments for this population. Among high school graduates, the positive assessment of genetic engineering has remained relatively stable, while negative assessments have declined slightly. This period has seen growth among high school graduates in uncertainty or in the belief that benefits equal harms. A similar pattern can be found for college graduates, with the majority believing that the benefits outweigh the harms, but an increasing proportion expressing either uncertainty or the view that benefits and harms are about equal. These findings are similar to what Nelkin (1977) saw regarding nuclear power in Sweden. Nelkin found that as information about nuclear power increased, the percentage of individuals who felt undecided about its use also increased.

Figure 7-15.
**Public assessment of genetic engineering**




See appendix table 7-22. *Science & Engineering Indicators – 1998*

These data show that a majority of the attentive publics for science and technology policy and for biomedical research (medical discoveries) has held a positive assessment of the benefits and harms of genetic engineering since 1985. (See appendix table 7-22.) For both attentive publics, the proportion of citizens who see the benefits and harms as about equal, or who cannot determine the difference, has been growing since 1985.

There is a clear difference by sex on this issue. In 1997, nearly 50 percent of men expressed a positive view of genetic engineering, compared to 37 percent of women. (See appendix table 7-22.) Approximately half of American men favored genetic engineering throughout the last decade. American women were nearly equally divided in 1997, with 37 percent indicating that the benefits outweigh the harms and 40 percent saying that the harms outweigh the benefits.[13]

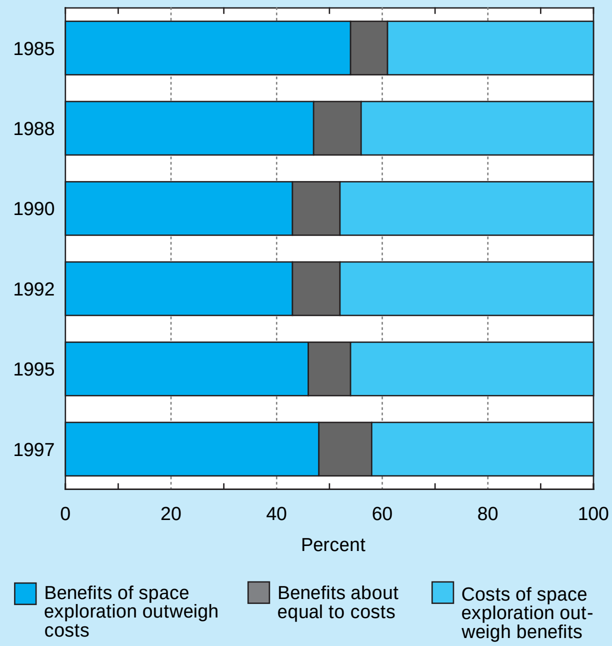
## Perceptions of Space Exploration

The balance between benefits and costs, rather than benefits and harms, has been important in assessment of the space program. While a majority supported the program in 1985, a small plurality of the public thought that the costs exceeded the benefits of space exploration in the early 1990s; public perceptions shifted toward the view that the benefits of space exploration exceeded its costs in 1997. (See figure 7-16 and appendix table 7-23.) This pattern of change offers an interesting insight into the role of attentive publics for low-salience issues.

In 1985, immediately prior to the Challenger accident, 54 percent of Americans thought that the benefits of the space program outweighed its costs. However, 66 percent of the attentive public for science and technology policy, and 74 percent of the attentive public for space exploration, believed that the benefits outweighed the costs and tended to hold strong feelings on this matter. The explosion of the Challenger produced an immediate increase in support for the space program in all segments of the American public (Miller 1987), but the grounding of the shuttle program for more than two years eroded a great deal of that support. Through the late 1980s and early 1990s, support was declining in both the general public and among those attentive to science policy. By 1992, however, fully 82 percent of the attentive public for space exploration believed that the benefits of the space program were greater than its costs. Although the interviews for the present *Indicators* study were largely completed prior to the Mars landing, a series of successful shuttle flights and a steady flow of images from the Hubble Space Telescope produced a small surge in public support.

[13]Hoban and Kendall (1993), in a study conducted in the United States, also found that men hold more positive views of biotechnology. A 1993 European study of attitudes toward biotechnology also found that men hold more positive attitudes toward biotechnology and genetic engineering (see Marlier 1993).

Figure 7-16.
**Public assessment of space exploration**




See appendix table 7-23. *Science & Engineering Indicators – 1998*

By the summer of 1997, 48 percent of American adults felt that the benefits of the space program exceeded its costs, while 42 percent of adults continued to think that the costs were greater than the benefits. (See appendix table 7-23.) At the same time, 66 percent of the attentive public for science and technology policy, and 76 percent of the attentive public for space exploration, indicated that the benefits exceeded the costs.

# Sources of Scientific and Technical Information

In recent decades, there has been a marked increase in the number and variety of sources providing information about science and technology.[14] Major weekly news magazines generally have a section on science or medicine and a section on computers and networks. The number of popular science books continues to grow, and many reviewers conclude that the quality of them is increasing. There has been substantial growth in cable television coverage of science and technology, and the number and quality of science-related sites on the World Wide Web grows daily. In this context, it is interesting to find out which Americans are using which kinds of science and technology information sources, and to what effect.

[14]See Lewenstein (1994) for a survey of public communications about science and technology in the United States.

## General Patterns of Information Acquisition

Building on trend data from previous *Science & Engineering Indicators* studies, it appears that Americans utilize numerous sources and institutions for scientific and technical information, but television and newspapers remain primary sources. In 1997, 68 percent of American adults reported that they watched a television news show for at least one hour on a typical day, and 46 percent indicated that they read a daily newspaper. (See figure 7-17 and appendix table 7-24.) Over one-quarter of Americans listen to one or more hours of radio news on a typical day, and 14 percent claim to read a weekly news magazine on a regular basis. Fifteen percent reported that they read a science magazine on a regular basis. These same results show that 70 percent of Americans use a public library at least once each year and that 45 percent claim to use a pubic library five or more times each year, although it is not possible to determine from the data whether science materials were utilized. Approximately 27 percent[15] of American adults now have access to the World Wide Web, and approximately 28 percent[16] report having an e-mail address at home or at work.

In broad terms, these indicators are threshold measures, reflecting the percentage of Americans who used various information sources more than some minimal threshold in a typical month or during the previous year. Using the same database, it is also possible to estimate the volume of use of these information sources and to place them all on the same metric—the number of uses or hours of use per year. By comparing different information sources on the same metric, it is possible to obtain a more useful picture of the patterns of potential scientific and technical information acquisition.

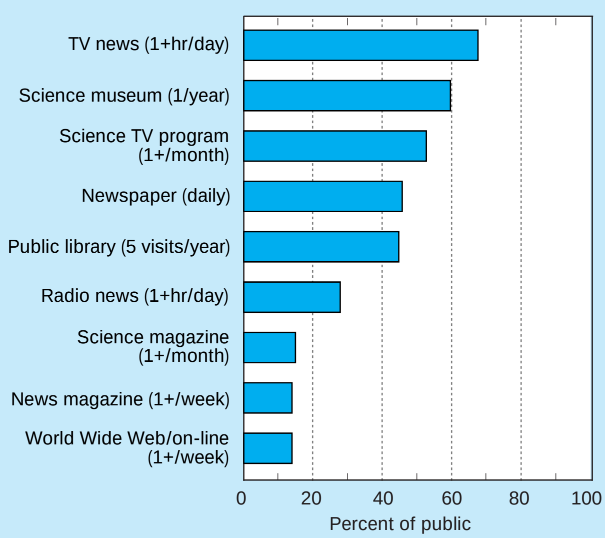
Regarding broadcast media, the 1997 results indicate that Americans watch an average of 1,075 hours of television each year and that 432 of those hours are devoted to television news. (See figure 7-18 and appendix table 7-25.) In this context, Americans report that they watch an average of 72 hours of science television per year. Since respondents in 1997 were asked the name of each show that they claimed to watch regularly or periodically, this is a credible estimate of viewership. The frequency of viewing science television shows is unrelated to the number of years of formal schooling or to the number of science and mathematics courses taken in high school and college. It is apparent, however, that individuals who subscribe to a cable television service or have a satellite dish watch significantly more science television shows than individuals without cable or satellite services. In 1997, cable subscribers reported watching an average of 84 hours of science television shows, compared to 35 hours for individuals without cable or satellite service. Men were significantly more likely to watch science television shows than were women.

Among print media, newspaper reading is dominant. In 1997, Americans reported reading an average of 196 newspapers during the previous 12 months. (See figure 7-19 and appendix table 7-25.) Comparatively, Americans read an average of three news magazines and two science magazines during the same 12-month period. Americans in 1997 used a public library 11 times during the year and borrowed 12 books and 2 videotapes from the public library. Sixty-one percent of American adults reported that they bought one or more books during the previous year; and 31 percent indicated that at least one of the purchased books involved science, mathematics, or technology (including computer use).

[15] This estimate includes individuals with access to the World Wide Web through their home computer, their work computer, and through Web television (not reported in the appendix tables).

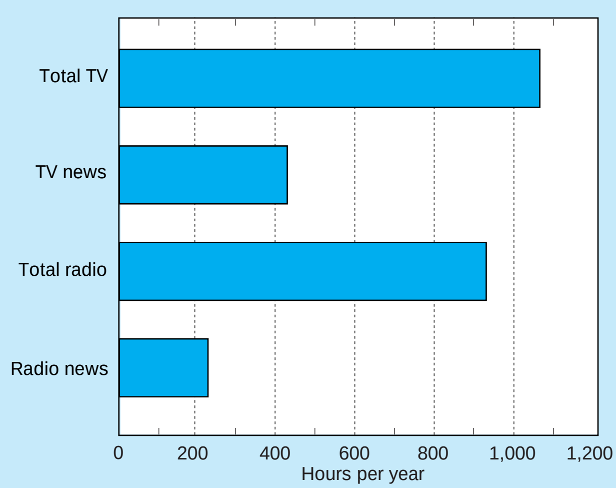
[16] This estimate combines those individuals who have an e-mail address either at home or at work, and is not reported as a separate category in the appendix tables.

Figure 7-17.
**Public use of selected information sources: 1997**



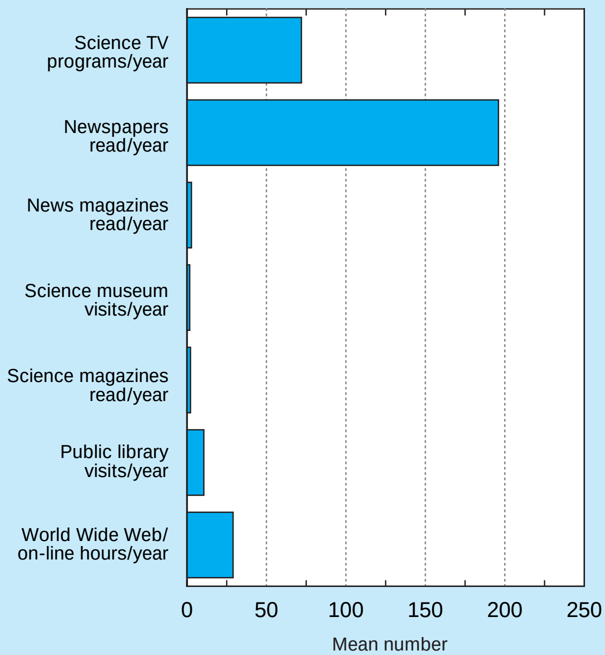

See appendix table 7-24. *Science & Engineering Indicators – 1998*

Figure 7-18.
**Mean number of hours per year of television and radio use: 1997**




See appendix table 7-25. *Science & Engineering Indicators – 1998*

Figure 7-19.
**Public use of selected information sources, on an annual basis: 1997**



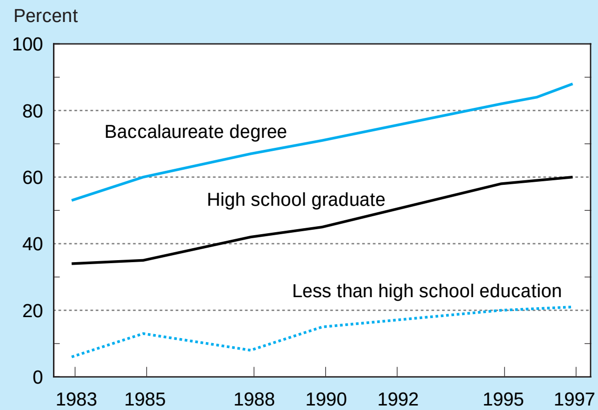

See appendix table 7-25. *Science & Engineering Indicators – 1998*

During the same 12-month period, Americans reported visiting a science museum, natural history museum, zoo, or aquarium an average of two times.

The reading of newspapers, news magazines, and science magazines is positively related to the number of years of formal schooling and the number of high school and college science and mathematics courses. (See appendix tables 7-24 and 7-25.) The individual with a graduate degree read approximately 238 newspapers, 6 news magazines, and 4 science magazines in a 12-month period. It appears that high school and college science and mathematics courses stimulate a lasting interest in science and technology, as reflected in the patterns of science magazine reading and science museum attendance. Men were significantly more likely to read a science magazine than were women.

Citizens attentive to science and technology policy issues displayed a high level of information consumption, utilizing both broadcast and print sources. Science policy attentives reported slightly more hours of television news viewing than other citizens, and they read significantly more newspapers than other Americans. (See appendix table 7-25.) Science and technology policy attentives read significantly more news magazines and science magazines than other citizens, and were more frequent visitors to public libraries than non-attentives. The members of the attentive public for science and technology policy were more likely than other Americans to visit a science and technology museum or other informal science learning resource.

Figure 7-20.
**Percentage of adults with access to a computer at work or home, by educational level**




See appendix table 7-26. *Science & Engineering Indicators – 1998*

## Use of New Information Technologies

The 1990s was a period of emergence of electronic media. Over the last decade, individual access to computers at work or at home has increased substantially and steadily. (See "The Use of Computer Technology in the United States.") By 1997, 57 percent of Americans reported using computers at work, at home, or both. (See figure 7-20 and appendix table 7-26.) Fully 88 percent of college graduates in the United States indicated that they used a computer at work or at home, compared to 60 percent of high school graduates and 21 percent of those who did not complete high school. In 1997, two-thirds of the attentive public for science and technology policy reported that they had regular access to a computer at work or at home.

The 1997 results show that Americans do a substantial amount of work on their computers. The average respondent reported spending 369 hours a year using a work computer and 130 hours using a home computer.[17]

A third of Americans have a home computer that includes a modem, and 18 percent report using an on-line or Internet service. (See appendix table 7-27.) Nearly two-thirds of Americans with a graduate degree or professional education have a home computer with a modem, and 41 percent reported that they use an on-line service. Over half of the attentive public for science and technology policy reported that they own a home computer and use it an average of 225 hours per year. Nearly half of this attentive public have a home computer with a modem, and are thus better positioned to make extensive use of the Internet and its information resources.

Twenty-nine percent of Americans indicated that they have a home computer that includes a CD-ROM reader, a technology that opens important new information resources ranging from larger reference works to collections of visual images with sound. The number of government agencies and private organizations

[17]The hours of computer use by individuals who reported that their place of business was in their home were counted as work hours.

## The Use of Computer Technology in the United States

Three new indicators collected for the first time in 1997 illustrate the broad and growing use of computers and computer-based technologies by American adults. First, 43 percent of Americans lived in a household in 1997 with one or more working computers, and 11 percent of Americans reported that they have more than one working computer in their home. (See figure 7-21.) In contrast, in 1983, only 8 percent of American adults had access to a home computer.

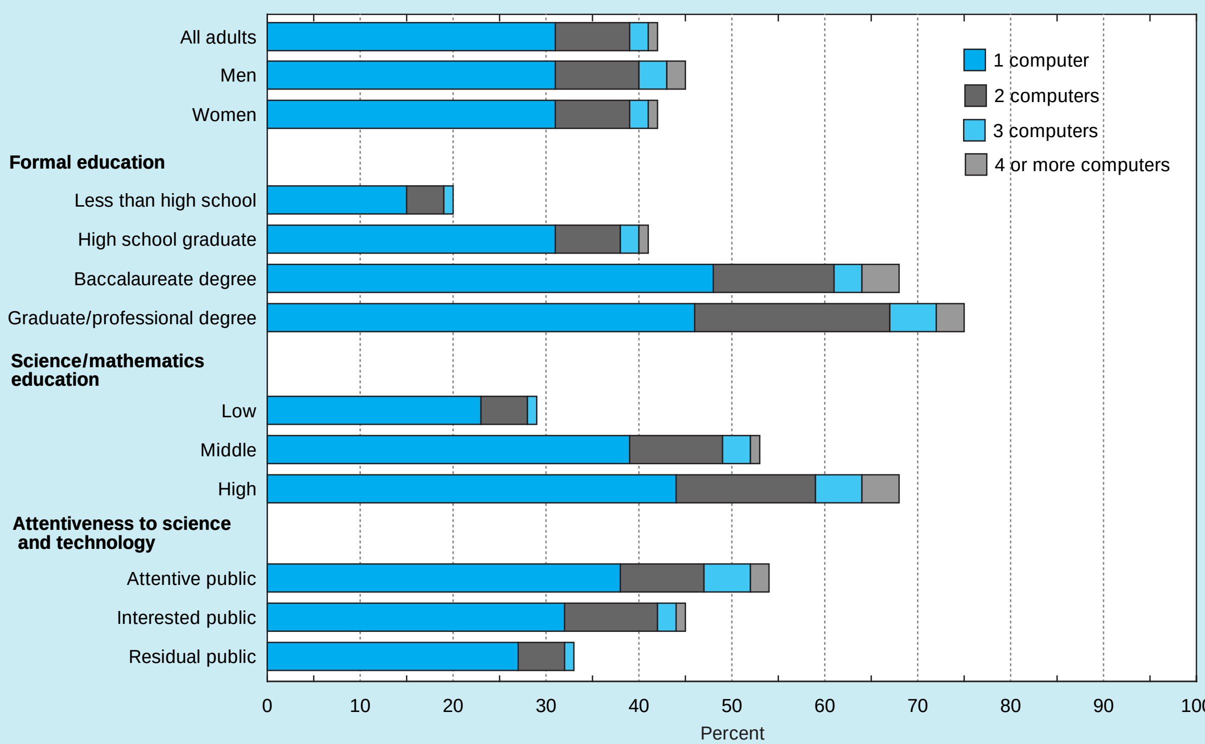
The distribution of home computers and of multiple home computers is strongly related to level of educational attainment. Three-quarters of adults with a graduate or professional degree own a home computer, with 29 percent having two or more working computers in their home. Similarly, 24 percent of individuals with extensive high school and college coursework in science and mathematics reported having two or more working computers in their home, as did 16 percent of the attentive public for science and technology.

Second, approximately 28 percent of Americans have an e-mail address, and 5 percent of U.S. adults—about 9 million individuals—have two or more e-mail addresses. (See figure 7-22.) The multiple e-mail addresses appear to reflect one e-mail address associated with work and a second e-mail address for home or family use.

The distribution of e-mail addresses is strongly related to the level of educational attainment. Slightly more than 60 percent of adults with a graduate or professional degree have at least one e-mail address, and 19 percent have two or more e-mail addresses. A similar pattern is found among baccalaureate-holders, with 55 percent having an e-mail address and 16 percent having two or more e-mail addresses. Furthermore, 60 percent of individuals with extensive high school and college coursework in science and mathematics reported having an e-mail address, as did 42 percent of the attentive public for science and technology.

Third, approximately 16 percent of Americans reported having access to the World Wide Web from their home computer in 1997. To understand how individuals use the Web, all respondents in the *Indicators* study were

Figure 7-21.
**Percentage of U.S. adults with one or more home computers: 1997**




SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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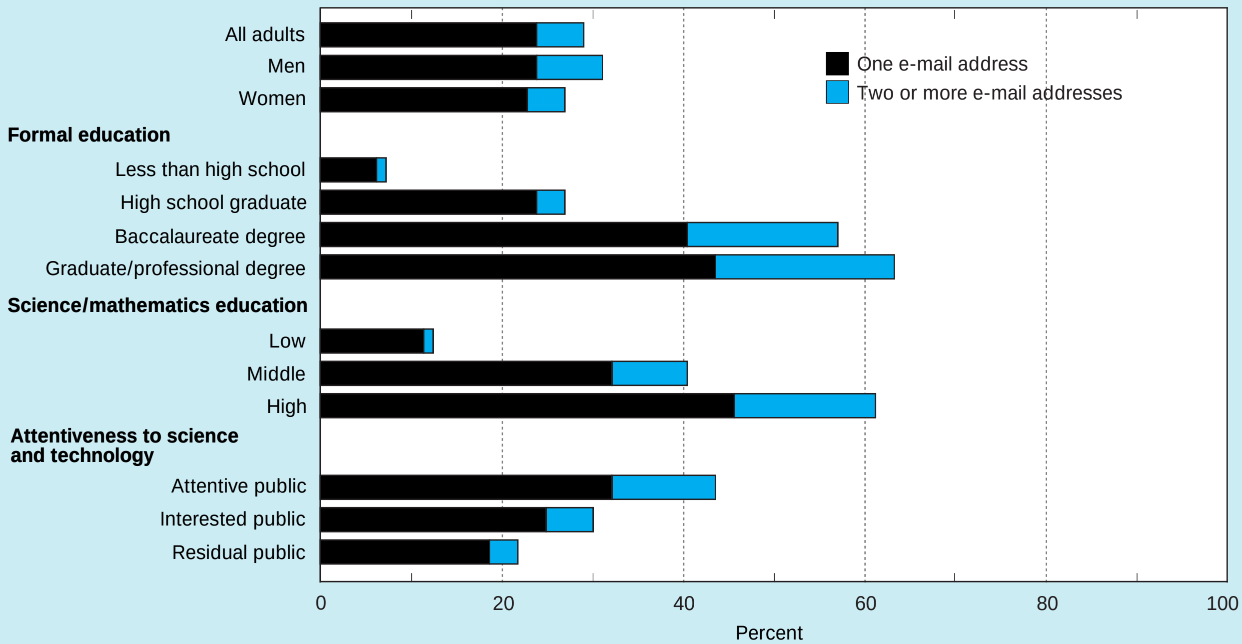
Figure 7-22.
**Percentage of U.S. adults with one or more e-mail addresses: 1997**



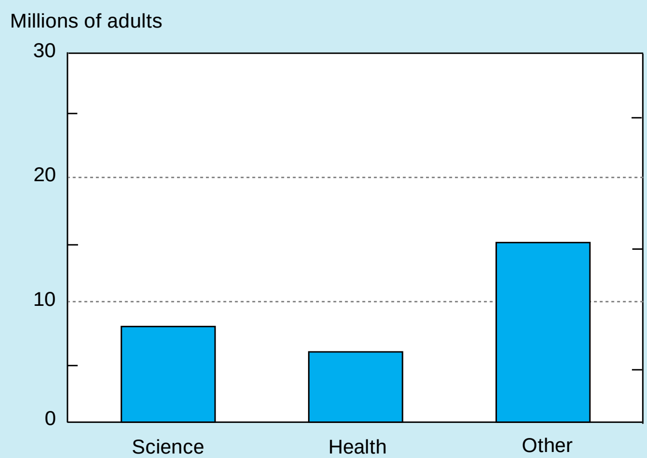

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

asked if they had tried to obtain any specific information from the Web, or whether they primarily browsed the various sites on the Web. Twelve percent of adults sampled—representing approximately 22 million people—indicated that they had previously tried to find some specific item of information on the Web. This pattern of response indicates that people are using the Web as they might use reference materials in a library.

Each respondent who reported some prior effort to find specific information on the Web was asked to describe in general terms the kind of information that he or she was seeking. An analysis of these responses indicated that approximately 6.5 million Americans had attempted to find some information on the Web about a specific health condition or problem, and approximately 8.8 million had tried to find some scientific information on the Web—including information on the space program, environmental information, and computer information. More than 15 million adults reported that they attempted to find other kinds of specific information on the Web. (See figure 7-23.)

While these results indicate that the vast majority of Americans do not presently use the Web as an information source, the relatively high level of use reported among the first segment of the American population to obtain Web access suggests that it is likely to become a major source of reference-type information in the decades ahead, as the total level of Web access continues to expand.

Figure 7-23.
**Estimated number of U.S. adults seeking specific information on the World Wide Web, by subject area: 1997**




SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

*Science & Engineering Indicators – 1998* that are distributing information in this medium is growing rapidly. As with other electronic media, better educated Americans are the most frequent users of this new technology.

Americans use a wide variety of sources to obtain new information, including information about science and technology. Americans with fewer years of formal education tend to rely on broadcast media, primarily television. College-educated Americans are frequent viewers of both television news and television science shows, but appear to rely more heavily on print media and, increasingly, on electronic information sources.

## Summary

Science and technology are subjects of substantial interest to Americans. Using a 100-point Index of Issue Interest, the mean level of interest in new scientific discoveries has increased from 61 in 1979 to 70 in 1997, indicating that science and technology are becoming an increasingly integral part of the American culture. Individuals with more years of formal education and more courses in science and mathematics are more likely to show a high level of interest in science and technology. Comparatively, 70 percent of Americans expressed a high level of interest in medical discoveries and 52 percent indicated that they were very interested in environmental issues, but only 32 percent reported a high level of interest in space exploration.

Despite the high levels of interest, only 19 percent of Americans think that they are very well-informed about science and 16 percent about the use of new inventions and technologies. Americans with more years of formal education and more courses in science and mathematics are significantly more likely to view themselves as being very well-informed than others, and men are significantly more likely to indicate that they are very well-informed about science and technology, holding constant the level of formal education and the level of science and mathematics education.

Using a more objective standard reveals that many Americans have a limited vocabulary of scientific and technical concepts. On a 0-100 scale, the mean score on the Index of Scientific Construct Understanding was 55. This score has remained relatively constant since 1988. Individuals with more years of formal schooling and more courses in science and mathematics obtained significantly higher scores, demonstrating the pervasive effect of science and mathematics education throughout the adult years. Compared to 13 other industrial nations, the mean score for American adults on the Index of Scientific Construct Understanding was tied for first with Denmark, closely followed by the Netherlands and Great Britain.

Only 27 percent of Americans understand the nature of scientific inquiry well enough to be able to make informed judgments about the scientific basis of results reported in the media. Public understanding of the nature of scientific inquiry was measured through questions about the meaning of scientific study and the reasons for the use of control groups in experiments. Individuals who have completed more years of formal schooling and more courses in science and mathematics were significantly more likely to understand the nature of scientific inquiry than other citizens.

Approximately 27 million Americans—14 percent—are attentive to science and technology policy issues, a level that has increased since 1995. In complex modern societies, it is not possible for citizens to become and remain informed about the full range of public policy areas, and some degree of issue specialization is inherent in these societies. About half of Americans indicate that they are interested in and informed about at least one public policy area, and, among those citizens who follow any public policy issues, it appears that most of them follow two or three issues at any given time.

Americans get most of their information about public policy issues from television news and newspapers. When placed on a uniform scale of the number of uses or hours per year, the public consumption of television news and newspapers dwarfs all other information sources. In 1997, Americans watched an average of 432 hours of television news and read 196 newspapers. During that period, Americans watched 72 hours of television science programs. Individuals with cable or satellite TV service watch more science television programs than those without this service.

Fifty-seven percent of Americans use a computer at home or at work, and computer use has increased steadily during the last decade. In 1997, Americans used a computer at work for 369 hours and used their home computer for an additional 130 hours. A significantly higher proportion of college graduates use a computer than individuals with fewer years of schooling.

In 1997, nearly one-third of Americans had a home computer that included a modem, and 18 percent of adults reported that they had used an on-line computer service during the preceding year. This is a significant increase in home access to on-line resources in the last two years alone. Moreover, 29 percent of adults in the United States reported having a home computer with a CD-ROM reader, opening additional information acquisition opportunities. Nearly two-thirds of Americans with a graduate or professional degree have a home computer with a modem, and 41 percent reported that they use an on-line service.

Americans continue to hold the scientific community in high regard. According to the most recent General Social Survey in 1996, approximately 40 percent of Americans expressed a great deal of confidence in the leadership of the scientific community and in the leadership of the medical community. This confidence has been stable for nearly two decades and is far higher than the levels reported for the leadership of most other major societal institutions.

Americans have high levels of belief in the promise of science and technology, with an average score of 70 on a 0-100 scale. They hold low levels of reservation about science and technology, with an average score of 37. These levels of reservation are the lowest reported among citizens of industrial nations. Compared to the citizens of 13 other industrial nations, Americans registered a strong belief in the promise of science and the lowest level of reservation about science and technology.

Seventy-five percent of Americans believe that the benefits of scientific research outweigh any present or potential harms. This level of positive assessment of scientific research has been stable for nearly two decades and reflects the high esteem in which the public holds the scientific community. College graduates and citizens attentive to science and technology policy hold even more positive views of science.

Despite their positive views of scientific research, Americans are deeply divided over the development and impact of several important technologies. They are relatively evenly divided on the benefits and harms of using nuclear power to generate electricity, and this division has persisted for more than a decade. A similar division occurs over the benefits and potential harms of genetic engineering, but there is a clearer difference by level of education, with college graduates holding much more positive views of genetic modification research. Regarding the space program, a small plurality of the general public believes that the benefits of the space program exceed its costs. College graduates and the attentive public for space exploration have continued to hold very positive attitudes toward the space program throughout the last decade.

Overall, the American public appears to continue to expect science and technology to improve the quality of life, and the scientific community is accorded a higher level of trust and confidence than other major societal institutions. Nonetheless, the concerns regarding several specific technologies indicate that the public has not given the scientific community a blank check. The public wants to know what is happening, and the scientific community needs to communicate its work ever more clearly and effectively.

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